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EDITORIAL

THE BRITISH VETERINARY ASSOCIATION

TITLES and names have been necessary ever since man acquired the art of speech and the ability to set forth his thoughts in some form of script. No doubt the first names to be used were short, and by inflection a complete thought could be expressed in a few syllables. As time progressed and the art of speech and the craft of the pen were developed, this simple method of expression gave place to a more elaborate device and a literary and vocal culture of high-falutin' style was born. As a result it took longer and longer to say less and less about the common objects on the earth, and the listener was put at more pains to understand and appreciate the descriptions. Now, this change may have done good, for it exercised and probably developed the mind. Euclid propounded his theories for much the same reason, and the modern bureaucrat evidently has the same object in mind when he sets down the innumerable Acts and Orders which try us so sorely. The bureaucrat excels Euclid, for in his verbosity he does not supply us with mental exercise alone, but he creates confusion even amongst the learned ones. Simple things are given long and sonorous titles and names which are often workable only when they are abbreviated to their initial letters. These become a sort of "Jargon," and are in familiar use by people who may have little knowledge of their pristine meaning. For many years the National Veterinary Medical Association of Great Britain and Ireland

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XUM

has suffered the inconvenience of a long and cumbersome title. In self-protection the members abbreviated it to N.V.M.A. No doubt there were those who did not know what the symbols meant. Be that as it may, the title had long outlived its usefulness, for the association was insular no longer, neither had it anything to do with the practice of human medicine. The word "National" would seem to indicate a parochial basis, and the term "Medical" tends to give an impression of subservience to a more powerful authority. Both conceptions are wrong, for the association has world-wide ramification and the profession has never been a dependant of medicine. The association has extended its influence so that it has divisions in many parts of the British Commonwealth, divisions which are young and vigorous and bring pulsating life to the parent body. As the British Dominions and Colonies advance in status and culture, so does the profession in these parts. Indeed, these things are interdependent, for the forward progress of a colony depends in no small measure upon the loyalty, the competence, the vitality and the integrity of the members of the profession who work therein.

The overseas men and women are keen and active members of the association. They do all in their power to enhance its prestige, and in turn it is right that the association should guard their interests.

The British people have many sterling qualities, not least of which is their respect for the past and its traditions, and sentiment runs high when any change is suggested. The new title is not the result of any sudden revolution, for it has been under discussion for almost twenty years. It is full time that there should be a change to a title which will be more in line with modern conditions and which will give added prestige to the association and, not least, ease the burden of the pen when one addresses a letter to headquarters on January the first, 1952.

XUM

GENERAL ARTICLES

STUDIES ON BRACKEN POISONING IN THE HORSE
Part II. *(Concluded)*

By E. T. REES EVANS, B.Sc., M.R.C.V.S., W. CHARLES EVANS,† M.Sc., Ph.D., F.R.I.C., and H. E. ROBERTS,* B.Sc., M.R.C.V.S.

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A RECORD of the main observations in tabulated form is to be found in Table 2.

TABLE 2

Table of observations during the experimental reproduction of bracken staggers in the horse.

Date 1949	Days of expt.	Weight in lb.	Rectal temp. °F.	Heart rate /min.	Blood pyruvate mg./100 ml.	Blood aneurin µg./100 ml.	Aneurin therapy (dose, in mg. subcutaneous injection).
July 8 ...	1	1,036	99.4	32	2.2	8.5	
July 14 ...	7	—	99.5	48	—	—	
July 22 ...	15	1,076	99.8	34	2.6	7.8	
Aug. 9 ...	33	—	104.5	52	3.5	3.25	
Aug. 10 ...	34	1,018	104	68	—	—	
Aug. 11 ...	35	—	103.5	68	6.25	2.5	
Aug. 12 ...	36	—	101.6	Arrhythmia	5.75	3.0	2(100)
Aug. 13 ...	37	—	103	70	3.2	—	100
Aug. 14 ...	38	—	103	66	—	—	100
Aug. 15 ...	39	942	102	40	3.5	—	100
Aug. 16 ...	40	—	100.4	40	—	—	100
Aug. 17 ...	41	989	100	48	3.2	—	100
Aug. 19 ...	43	1,030	101.3	35	2.9	11.5	
Aug. 22 ...	46	—	100.4	48	2.1	7.0	
Aug. 26 ...	50	—	100.5	32	2.3	—	
Aug. 31 ...	55	1,018	100.8	38	—	—	
Sept. 7 ...	62	982	98.5	38	—	—	
Sept. 16 ...	71	968	100	28	4.2	4.0	
Sept. 21 ...	76	964	101	28	5.8	2.8	
Sept. 22 ...	77	—	102 (a.m.) 103.6 (p.m.)	80 (approx.)	8.5	—	4(100)
Sept. 23 ...	78	Dead					

Comments on the Observations Made During the Course of the Experimental Period

WEIGHT RECORDS.

GRAPH 1 shows that during the first three weeks of the bracken-hay feeding the horse put on weight. After this period a rapid loss occurred, which was magnified by the anorexia; the response to aneurin therapy was obvious in a day or two, and was of a dramatic nature. The second onset of bracken staggers occurred within approximately a similar interval to the first—i.e., 30 days. It is, perhaps, significant that such a low weight was not reached during the second bout of the attack, although death ensued.

TEMPERATURE RECORDS.

Hadwen and Bruce[5] make special comment on the constancy of the rectal temperatures in their experimental horses during the whole period of reproduc-

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tion of bracken staggers. This is in striking contrast to the pyrexia invariably observed in clinical bovine bracken poisoning. During the first bout of staggers, the horse in our experiment showed a definite elevated temperature, which, however, was absent during the second cycle of reproduction of the disease, until death was imminent. We have reason to believe that during the first cycle there might have been a superimposed infection (tracheal rattle, mucopurulent nasal discharge, leucocytosis, etc.), which, however, cleared up rapidly with B_1 therapy.

BIOCHEMICAL RESULTS.

Table 2 shows that during both periods of illness there was a very marked decrease in the aneurin level, paralleled by an abnormally high pyruvic acid content of the blood. Such a state of affairs was also encountered in the naturally

TABLE

Date 1949	Days of experiment.	Red blood cells ($x10^6$/cmm.).	Hæmoglobin (g/100 ml.).	White blood cells (/cmm.).	Packed cell volume.	Fragility.	Specific gravity (blood
July 8	1	8.0	11.2	7,500	30.0	0.40 - 0.60	1.0530
July 16	9	7.5	10.64	15,000	31.0	—	1.0530
July 25	18	7.2	11.06	12,000	28.0	0.40 - 0.60	1.0525
Aug. 2	26	7.5	10.36	15,000	33.0	0.44 - 0.60	1.0555
Aug. 9	33	6.0	8.4	17,000	23.0	0.44 - 0.60	1.0455
Aug. 11	35	4.6	7.7	19,000	21.0	0.44 - 0.56	1.0450
Aug. 12	36	7.2	10.5	21,500	28.0	0.44 - 0.56	1.0550
Aug. 13	37	6.0	9.10	12,000	26.0	0.44 - 0.56	1.0495
Aug. 15	39	5.8	8.40	11,000	25.0	0.44 - 0.60	1.0500
Aug. 17	41	5.8	8.26	15,000	25.0	0.44 - 0.60	1.0475
Aug. 19	43	6.5	9.80	12,000	27.0	0.44 - 0.56	1.0500
Aug. 22	46	6.3	9.52	15,000	26.0	0.44 - 0.56	1.0482
Aug. 26	50	6.8	9.52	11,000	27.0	0.40 - 0.56	1.0485
Aug. 31	55	6.5	9.52	8,000	26.5	0.40 - 0.56	1.0485
Sept. 7	62	7.0	10.78	12,000	29.5	0.44 - 0.56	1.0522
Sept. 16	71	6.3	10.50	11,400	28.5	0.44 - 0.56	1.0515
Sept. 21	76	6.8	10.22	8,300	28.3	—	1.0490
Sept. 22	77	6.8	10.71	8,600	32.6	—	1.0545

occurring field cases of bracken staggers, to be described later (see Table 4). Moreover, the effect of the administration of aneurin was evident in a day or two, in that the blood pyruvates showed a prompt fall to within normal limits. The work of Peters and his collaborators has amply demonstrated that the sequence of changes in blood aneurin and pyruvic acid concentration, similar to those encountered in horse bracken poisoning, is the outstanding biochemical lesion characterising authentic avitaminosis B_1.

HÆMATOLOGICAL OBSERVATIONS.

Consultation of Graphs 2 and 3 and Table 3 shows that in the first cycle of reproduction of the syndrome, marked hæmatological changes occurred, which were not observed during the second bout. Absence of hæmatological changes was recorded by Hadwen and Bruce.[5]

The erythrocytes remained fairly constant throughout, except for a reduction on August 11, 1949; this was reflected in the hæmoglobin and packed cell volume, which were also lowered. On the following day, however, normal values were obtained.

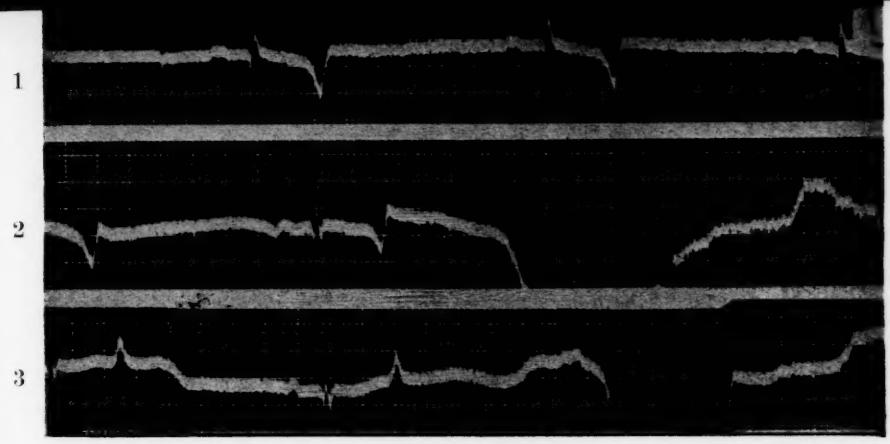


FIG. 9
Electrocardiogram of bracken-fed horse.

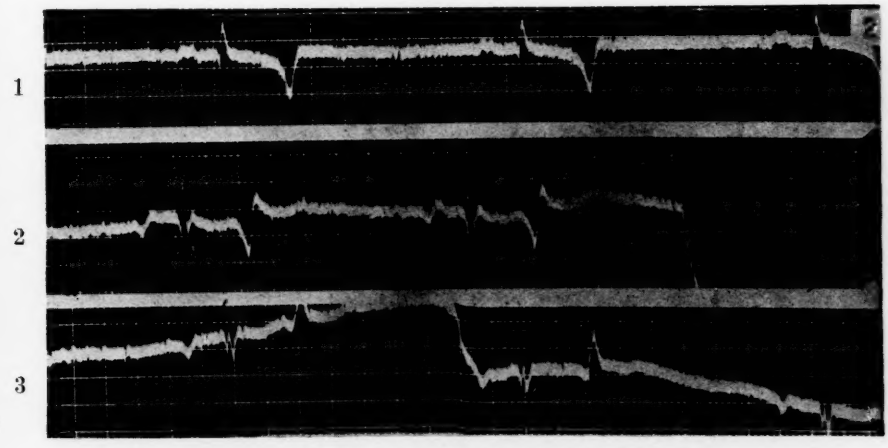


FIG. 10
Electrocardiogram of bracken-fed horse.

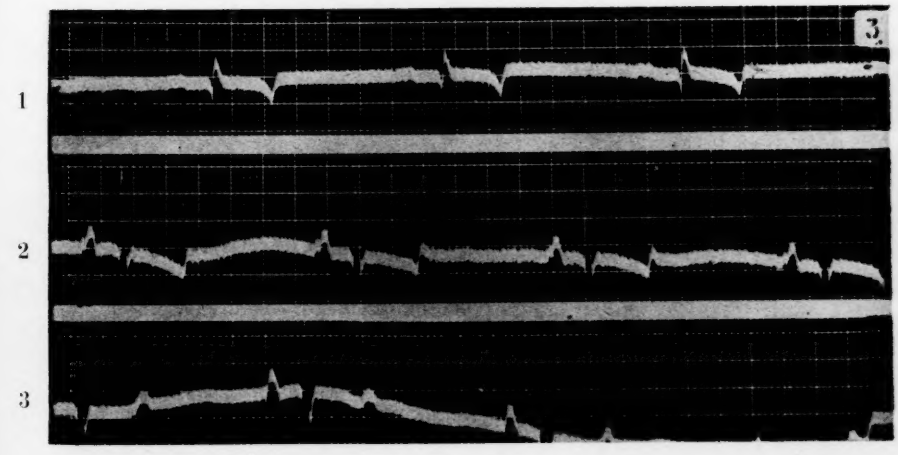


FIG. 11
Electrocardiogram of normal horse.

(Article by Evans, Evans and Roberts, page 399)

FIG. 12

FIG. 13
Pony A showing severe stagger symptoms.

(*Article by Evans, Evans and Roberts, page* 399)

During the first cycle an early leucocytosis developed, which reached a maximum on the vital day (August 8); fluctuations followed this until the last few days, when normal values were again recorded. In the field cases, which are described later in this paper, leucocytosis was present in both animals; in pony (A) this vanished on recovery, but for pony (B) no comparable values were taken, although it is reasonable to assume that a similar return to normal must have occurred.

The significance of the above finding is difficult to assess. In the experimental mare during the leucocytosis, there co-existed an elevated temperature, a mucopurulent nasal discharge, and a pica when it ate chunks of wood from the manger. With the ponies in the field a fright effect might have resulted in

		GRANULOCYTES.			AGRANULOCYTES.	
Specific gravity (plasma).	Mature neutrophils.	Immature neutrophils.	Eosinophils.	Basophils.	Lymphocytes.	Monocytes.
1.0280	4,275 (57%)	75 (1%)	675 (9%)	Nil	2,100 (28%)	375 (5%)
1.0285	10,650 (71%)	750 (5%)	1,200 (8%)	"	1,930 (13%)	450 (3%)
1.0280	9,000 (75%)	600 (5%)	240 (2%)	"	1,320 (11%)	840 (7%)
1.0295	10,800 (72%)	900 (6%)	150 (1%)	"	2,400 (16%)	750 (5%)
1.0265	12,070 (71%)	1,700 (10%)	Nil	"	1,870 (11%)	1,360 (8%)
1.0268	14,440 (76%)	1,330 (7%)	"	"	1,330 (7%)	1,900 (10%)
1.0300	17,805 (83%)	645 (3%)	"	"	1,075 (5%)	1,935 (9%)
1.0290	9,600 (80%)	360 (3%)	"	"	960 (8%)	1,080 (9%)
1.0292	6,930 (63%)	220 (2%)	"	"	2,310 (21%)	1,540 (14%)
1.0275	9,450 (63%)	1,350 (4%)	150 (1%)	"	3,450 (23%)	600 (4%)
1.0280	8,760 (73%)	480 (4%)	840 (7%)	"	1,560 (13%)	360 (3%)
1.0265	11,850 (79%)	600 (4%)	450 (3%)	"	1,500 (10%)	600 (4%)
1.0265	7,590 (69%)	330 (3%)	330 (3%)	"	2,310 (21%)	400 (4%)
1.0260	4,560 (57%)	240 (3%)	880 (11%)	160 (2%)	1,760 (22%)	450 (5%)
1.0275	7,440 (62%)	240 (2%)	840 (7%)	Nil	2,760 (23%)	720 (6%)
1.0275	7,752 (68%)	228 (2%)	Nil	"	2,736 (24%)	684 (6%)
1.0285	5,146 (62%)	83 (1%)	"	"	2,739 (33%)	332 (4%)
1.0270	6,364 (74%)	602 (7%)	"	"	1,204 (14%)	430 (5%)

a leucocytosis being shown, since they were unbroken, and thus resented handling for the first few times.

The eosinophils showed a pronounced change in that they vanished during the stagger cycles in the experimental animal, and also, but to a lesser extent, in the field cases.

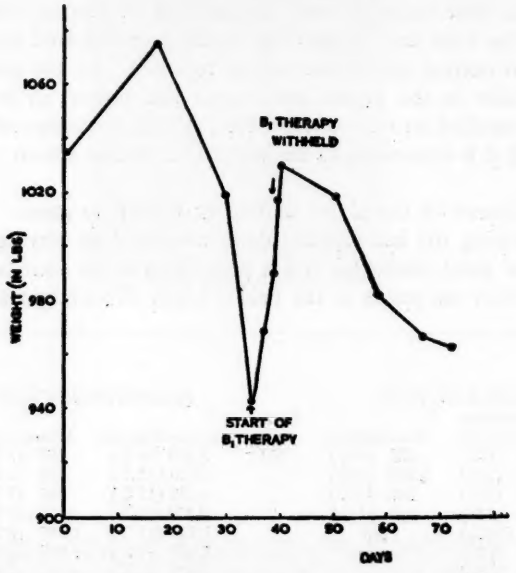
Platelet estimations carried out on ponies A and B gave interesting results. During the period of illness they were low, but after aneurin therapy and recovery they rose to values well within the normal range. Similar trends have been observed in preliminary work on rats maintained on bracken diets.[23]

Hæmatological changes appear important in the consideration of bovine bracken poisoning with its prominent hæmorrhagic symptoms.

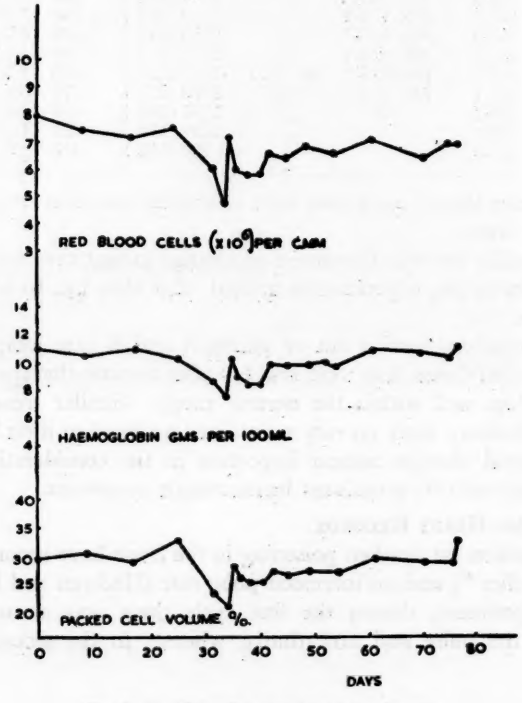
Pulse Rates and Heart Records.

Previous workers on bracken poisoning in the horse have reported a slowing of the pulse (Muller[4]) and an increased pulse rate (Hadwen and Bruce[5]).

In this experiment, during the first cycle there was an unquestionable acceleration of the pulse and arrhythmia, whereas in the second bout there



Graph 1. Showing weight-curve during course of experiment.



Graph 2. Showing erythrocyte picture

appeared to be a slight bradycardia, followed by tachycardia and arrhythmia during collapse. Cases encountered in the field usually show a bradycardia, except when the symptoms are severe, when they may show tachycardia.

INTERNAL APPEARANCES.

Evidence of cardiac irregularities had already been met with during the first cycle. Circumstances allowed the recording of an electrocardiogram of the experimental horse on the evening of September 21, 1949, when definite staggers were exhibited, i.e., during the second cycle. There was a difference between the pulse rate recorded manually from the mandibular point, and the heart rate from the electrocardiograph tracing (28/min. and 33/min. respectively). The rhythm appeared regular, but extra systoles were observed on the instrument before it was recording. Figs. 9 and 10 are the actual tracings, obtained from the horse when showing the clinical syndrome of bracken staggers; Below it, Fig. 11, for comparison, that of a normal horse of about the same type and age, taken the same evening on the same farm. As is evident, the P-wave is deeply notched in lead 1, diphasic in lead 2, and inverted in lead 3. The Q.R.S. complexes are normal in leads 1 and 2, and are of a duration of 0.08 seconds; they are, however, definitely abnormal in lead 3, with deep Q and S waves. The P-R interval is 0.2 seconds. The T-waves are very deep in all leads, T_1 being deeply inverted and definitely abnormal in amplitude; T_2 is biphasic, and T_3 is of abnormal amplitude, upright and sharply pointed.

The form of the Q.R.S. complex in lead 3, together with the pointed T-waves of abnormal amplitude, are suggestive of myocardial insufficiency or coronary ischæmia. The post-mortem findings, two days later, corroborated cardiac failure recognised by the electrocardiograph.

POST-MORTEM EXAMINATION.

This was carried out approximately within two and a half hours after death, the carcass being still warm, and rigor mortis present. Below is a summary of the main findings:—

External appearance:—

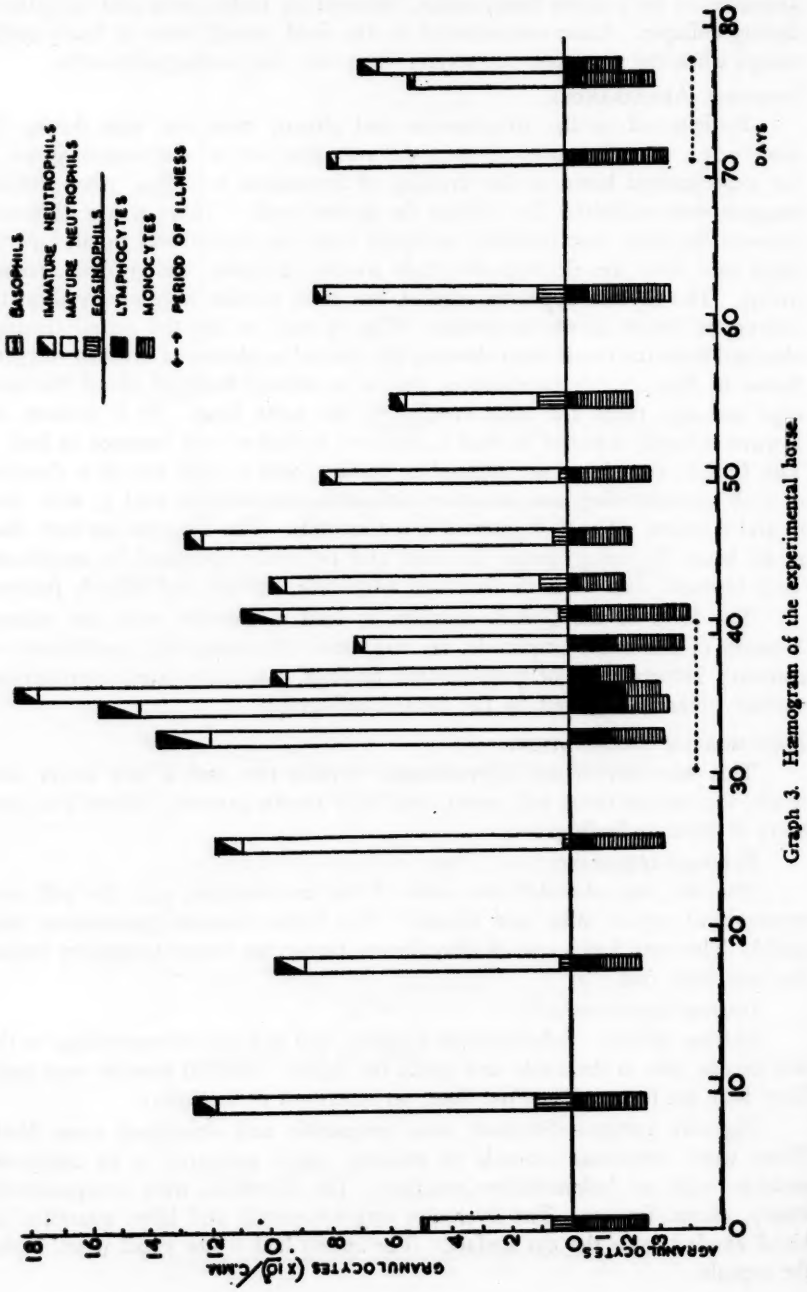
The skin was abraided over most of the prominences, e.g., the poll over supraorbital region, stifle and elbows. The visible mucous membranes were pallid. The teeth had a coat of dirty, brown tartar; the corner temporary incisor had not been cast.

Internal appearances:—

Carcass lesions.—Subcutaneous bruising and œdema corresponding to the skin lesions, also in the axilla and inside the thighs. Skeletal muscles were pale. Very little fat lining abdominal floor, on omentum or mesentery.

Digestive system.—Stomach was tympanitic and contained some food. There were numerous wounds on mucosa, which appeared to be traumatic incisions with no inflammatory reaction. The intestines were comparatively empty, except for gas. The liver was very congested, and large quantities of blood exuded from the cut surface. The spleen had a few small petechiæ on the capsule.

XUM



Graph 3. Hæmogram of the experimental horse.

Respiratory system.—Excess pleural effusion. Both lungs were severely congested, the right lung more so than the left (the horse was lying on the right side).

Circulatory system.—Excess pericardial effusion. Petechial hæmorrhages extended along the coronary grooves and surrounding the roots of the large blood vessels. The myocardium of the right ventricle appeared flabby, generally pale, but with areas darker in colour. There were foci of a dense white colour on an almost opaque, white endocardium. Both anterior and posterior vena cavæ were distended with uncoagulated blood and the renal veins were similarly engorged.

Urinary system.—Both kidneys were congested, the glomeruli standing out as hæmorrhagic dots. The bladder was filled with a thick, turbid urine.

Nervous system.—There may have been an excess quantity of cerebro-spinal fluid. The sciatic nerve showed a few bruised and œdematous areas.

Morbid Histology.

Sections of liver, lung and kidney confirmed the macroscopic lesions of a very severe congestion of these organs, with distension of capillaries and sinusoids. Sections of brain and spinal cord in various regions showed no obvious abnormality, apart from a possible distension of the capillaries in the former. There was no visible abnormality in the sciatic and brachial nerve sections. Sections of the heart tissues revealed the following abnormalities: The endocardium of the right auricle was thickened, due to œdema, so also was the subendocardial region. The myocardium of the same chamber showed a loose structure, due to œdema of the interstitial space, and numerous discrete areas of fibrosis. The myofibrils were swollen, the striations being indistinct, and on cross-section appeared hollow, with disappearance of nuclei. There was evidence of fragmentation. Similar changes were present in the right ventricular myocardium; the Purkinje fibres here were degenerated, with nuclear disappearance, and on cross-section also appeared hollow. The left ventricle fibres showed similar changes. From the whole post-mortem picture, it was concluded that this was consistent with death from cardiac failure.

The Treatment of a Naturally Occurring Outbreak of Bracken Staggers in Ponies.

With the collaboration of W. MORRIS-JONES, B.V.Sc., M.R.C.V.S.,
Aberystwyth

Six ponies had been turned out in the second week of April, 1950, to graze a bank at Tan-y-Bwlch Farm, near Aberystwyth. The area of approximately four acres, when seen in early June, was liberally infested with bracken, gorse, and other sundry rough vegetation. There was about an acre of grassland distributed in patches throughout the bank. The animals appeared to be doing well until June 6, when two were seen to have lost condition and showed stagger symptoms. Veterinary attention was sought on June 7.

Upon inspection of the bank it was seen that the pasture offered had been grazed bare, and there was visual evidence of bracken having been eaten. The

weather had been dry for the previous three weeks, which was not conducive to a good growth of grass.

The two affected ponies were unbroken, two-year-old fillies, one a Welsh pony (A) of 13.3 hands high, the other a Welsh mountain pony (B).

EXAMINATION OF THE ANIMALS.

The bay pony (A) was staggering severely (Figs. 12 and 13); it was thin, with the belly tucked up, and had a very scurfy coat. The fæces were well formed and rather hard; the conjunctiva was congested. Difficulty was experienced in taking the pulse from the submaxillary artery. The heart rate was 65 per minute, being very irregular, with a prolongation between the *lub* and *dub* sounds, which were both of approximately the same intensity. The standing posture adopted was with head down, feet well apart, and an unmistakably dejected look. On walking downhill, the animal swayed from side to side. A tap under the jaw set up an almost convulsive state, a great effort being needed to regain posture, followed by the adoption of a morose appearance.

The chestnut pony (B) did not show such severe symptoms as (A); it was more excitable, with a thin, scurfy coat. The conjunctiva was congested, and the pulse 80 per minute, but very irregular. After exercise the heart beat was very loud and fast, and could be heard some distance away from the animal.

OBSERVATIONS AND TREATMENT.

Date.	*Remarks.*
1950	
June 7	Both animals were bled for laboratory investigations and then injected subcutaneously with 50 mg. aneurin. They were also removed from the incriminated, bracken-infested bank to a clean field with, however, a poor herbage growth.
June 9	The ponies were definitely better, but still not co-ordinating their movements properly. They were bled again, and received a further 50 mg. aneurin by subcutaneous injection.
June 12	The chestnut pony (B) appeared almost normal, and the bay (A) vastly improved.
June 21	Blood was withdrawn from both ponies. It was noticed that after some exertion the large bay (A) developed signs of uncertainty of gait, whilst the chestnut (B) galloped normally. The bodily condition had improved considerably in both animals, with bellies full and their coats less harsh. In view of the persistence of some clinical symptoms in (A) (a relatively high blood pyruvate and low platelet count) it was given a further 100 mg. aneurin subcutaneously.
July 6	Recovery appeared complete in both animals. Their coats had developed a sheen and both had put on flesh, even though the pasture was not of the best.

Table 4 records results of some hæmatological and biochemical observations on the blood of these animals during the period of treatment.

Discussion

There seems little doubt that the condition known as "bracken staggers" in the horse is in reality a nutritional disease, presenting all the features of aneurin deficiency, and responding to treatment by this vitamin. This conclusion, which we briefly reported previously,[14] has since been independently confirmed by Carpenter, Phillipson and Thomson.[19]

Biochemical work on the nature of the anti-aneurin factor in bracken has enabled us to understand how the effect of this plant is brought about on rats and horses.[12] A plant thiaminase is present in the filicineæ we have examined (*Pteris aquilina, Aspidium filix mas.*) and equisetaceæ (*Equisetum arvense* and *E. palustre*). This enzyme is absent from all the common pasture grasses and clovers, but an exhaustive survey of its occurrence has not yet been made.

Exposure of the thiaminase-containing plants to a temperature of 100 degrees C. by steaming for 30 mins., or autoclaving for a shorter time, completely inactivates this enzyme. The plants are then rendered quite incapable of producing avitaminosis B_1 when included in the diet of rats at a level which was invariably effective before the heat treatment. When green bracken is shredded by a robust-cutter, and then dried in a grass-drier of the Farmac type* (pneumatic drum type), the product had again lost all its thiaminase activity. If, however, drying is allowed to take place on a tray by a current of hot air, the product may still possess appreciable activity. Once the bracken is dry, it can be subjected to dry heat at 100 degrees C. for a considerable length of time without complete loss of activity, whilst it is inactivated in a few minutes by steam.[12]

In the present work the clinical observations made during the first attack of staggers, viz., high temperature and polymorphonuclear leucocytosis, which were not apparent during the second bout, were possibly due to a slight complication of unknown origin.

Another difference observed between the two cycles was the existence of tachycardia in the first, whereas bradycardia was more prevalent during the second onset of the condition, followed by tachycardia during the short, severe, terminal phase of the disease. Arrythmia was, however, present during both periods of illness. It was our impression that the interval between the onset of symptoms and the stage of extreme crisis was much shorter during the second attack compared with the first, suggesting that the horse was much more sensitive to a vitamin B_1 deficiency on the second occasion. This phenomenon has also been observed with rats and pigeons. It seems evident that in horse bracken poisoning, cardiac involvement is an important consequence, and has to be carefully watched in advanced cases.

Aneurin deficiency in the horse has probably been reproduced before. Thus Naito, Shimanura, and Kuwabara[24] fed horses on a diet of polished rice, rice straw supplemented with cod liver oil, and minerals, and produced anorexia,

* We are grateful to Mr. D. S. Davies, Principal, Madryn Farm Institute, Caernarvonshire, for arranging to cut a load of green bracken for this purpose, and to Mr. P. Temple for putting it through the Farmac drier.

XUM

cardiac irregularities, and, finally, motor disturbances such as paralysis and paresis. These symptoms took 4-12 months to appear, and disappeared on administration of a "vitamin B" preparation, without otherwise changing the diet. Horses which had been starved for three weeks so as to lose 34 per cent of their body-weight did not develop similar symptoms. Carlstrom and Hjarre[25] record that military horses receiving a poor quality hay diet developed anorexia, emaciation and inco-ordination; the blood contained raised amounts of pyruvic acid, lactic acid, and bi-sulphite binding substances. Dried yeast cured the symptoms, and the blood levels became normal. Carrol, Goss and Howell[26]

TABLE 4

Date. 1950	Horse.	Blood pyruvate (mg. per 100 ml.).	Blood aneurin (µg. per 100 ml.).	Red blood cells ($x10^6$ per cmm.).	Hæmoglobin (g. per 100 ml.).	White blood cells (per cmm.).	Platelets (per cmm.).	Packed cell volume (%)	Specific gravity blood.	Specific gravity plasma.	Quality.
June 7	... A	4.0	3.5	8.0	12.5	16,500	80,000	34	1.0588	1.0[illegible]	[illegible]44-0.64
	... B	6.0	4.0	9.0	13.4	13,200	70,000	36	1.0605	1.0[illegible]	[illegible]44-0.60
June 9	... A	3.0	4.5	8.0	11.62	16,700	—	31	1.0540	1.0[illegible]	[illegible]40-0.64
	... B	2.5	9.5	9.7	12.04	17,600	—	33	1.0570	1.0[illegible]	[illegible]40-0.60
June 21	... A	4.0	4.5	6.8	9.94	12,000	50,000	27	1.0510	1.0[illegible]	[illegible]44-0.68
	... B	2.0	8.0	8.7	12.32	15,000	310,000	35	1.0600	1.0[illegible]	[illegible]44-0.60
July 6	... A	2.0	6.8	9.0	12.6	9,000	240,000	34	1.0565	1.0[illegible]	— —

maintained Percheron horses on a diet low in the B vitamins—dried beet pulp 68 parts, glucose 20 parts, washed casein 5 parts, washed fish meal 5 parts, spent bone black 2 parts, sodium chloride (block) *ad lib*. In about 19 weeks they developed signs of vitamin B_1 deficiency and some died, post-mortem revealing a dilated and hypertrophied heart. They record a blood pyruvic acid level of 6.25 mg. per 100 ml. of blood in one animal showing anorexia and inco-ordination; 200 mg. aneurin administered intravenously quickly relieved the symptoms, and the blood pyruvate fell to 0.94 mg. per 100 ml. within four weeks, the animal in the meantime receiving 40 mg. vitamin B_1 daily by subcutaneous injection. Of considerable interest was the finding by these workers that appreciable microbial syntheses of several B vitamins took place in the intestinal tract of the horse, especially in the cæcum and large intestine, thus, with respect to aneurin itself, the levels of this vitamin in the contents of different parts of the gut are shown in the accompanying table

Vitamin B_1 content in µg. per g. dried material.

Horse ration.	Duodenum.	Ileum.	Cæcum.	Anterior portion (large colon).	Anterior portion (small colon).
1.1	0.5	2.2	7.1	17.8	7.8

It cannot be assumed, however, that this supply from microbial synthesis is readily available to the animal, and the work clearly shows that the horse is dependent on a sufficiency of aneurin in the ration.

It has been repeatedly demonstrated that considerable synthesis of the B vitamins also occurs in the rumen of cattle and sheep (see, for instance, McElroy and Goss[27]), but because of the anatomical differences in the alimentary tract of ruminants and horses, the problem of absorption is quite different. In ruminants it is reasonable to suppose that vitamins formed by micro-

XUM

organisms in the rumen are available to the host after autolysis and digestion in the same way as vitamins in the food. There is little opportunity for this to occur in the horse.

In a later work, Carroll[28] found that an average daily intake of 30 mg. aneurin hydrochloride (2.5 mg. per 100 lb. body-weight) was sufficient to prevent depletion of this vitamin in the skeletal muscle of the horse.

A condition termed "forage anæmia" occurs naturally in horses on forest pastures of Scandinavia and Finland, which seems to be due to a deficiency of aneurin, as judged by symptoms and response to therapy. Some relationship

TABLE 4

Specific gravity of plasma	Fragility.	GRANULOCYTES. Mature neutrophils.	Immature neutrophils.	Eosinophils.	Basophils.	AGRANULOCYTES. Lymphocytes.	Monocytes.	B_1 Therapy mg. (subcut.).
1.03	0.44-0.64	9,735 (59%)	330 (2%)	165 (1%)	165 (1%)	4,290 (26%)	1,815 (11%)	50
1.03	0.44-0.60	5,676 (43%)	396 (3%)	528 (4%)	132 (1%)	5,676 (43%)	792 (6%)	50
1.02	0.40-0.64	9,018 (54%)	668 (4%)	167 (1%)	None	5,845 (35%)	1,002 (6%)	50
1.03	0.40-0.60	7,568 (43%)	704 (4%)	352 (2%)	88 (0.5%)	7,744 (44%)	1,144 (6.5%)	50
1.02	0.44-0.68	5,760 (48%)	120 (1%)	720 (6%)	None	4,560 (38%)	840 (7%)	100
1.03	0.44-0.60	5,250 (35%)	300 (2%)	750 (5%)	None	8,100 (54%)	600 (4%)	—
1.02	— —	2,700 (30%)	180 (2%)	720 (8%)	None	5,220 (58%)	180 (2%)	—

was claimed between excess manganese in the fodder and its low aneurin content; thus Carlstrom and Hjarre[29] state that aneurin disappears more rapidly from "affected" Norrland hay than from normal hay, suggesting that the vitamin is destroyed by oxidation, in the presence of large amounts of manganese compounds. Svanberg,[30] however, could not find a clear correlation between the manganese content of the vegetation and the incidence of anæmia. The position is often complicated by the occurrence of an infectious anæmia apparently superimposed on the nutritional condition. There seems to be no doubt, however, from Carlstrom's work, that affected Norrland hay can be very low in its aneurin content as estimated by the thiochrome method (0·1 μg. per g.); prolonged feeding on such a ration would, amongst other things, produce avitaminosis B_1.

A considerable literature exists on the pathology of avitaminosis B_1 (see, for instance, Follis[31]), since this condition has now been produced in a variety of species, viz., rats, mice, hamsters, cats, dogs, foxes, swine, calves, horses, poultry, and man. An inherent difficulty in any experiment involving aneurin deficiency is the correct assessment of the specific changes due to the lack of the vitamin, and the non-specific ones brought about by ancillary effects such as anorexia.

According to Wintrobe and his collaborators,[32] and Pantridge,[33] B_1 deficiency in pigs gives rise primarily to cardiac lesions, which were identified electrocardiographically and on histological examination. These predominantly involve the auricular myocardium and the cells of the conducting system in the ventricle. The myocardial lesions consist of areas showing muscular degeneration and necrosis with cellular infiltration and fibrous replacement. An acute hyaline necrosis is also seen in the Purkinje fibres.

Evans, Carlson, and Green[34] described the pathological lesions in Chastek paralysis, produced by feeding silver foxes on a diet containing raw carp. The most significant lesions here occur in the brain and spinal cord. These appear as small hæmorrhages, often macroscopic, in the grey matter, bilaterally symmetrical, involving certain paraventricular nuclei, the inferior olive and cortex of the splenial gyrus. The heart is also involved, showing massive degeneration with cloudy swelling. Microscopically, there is focal necrosis and large nucleoli in the myocardial fibres, with connective tissue proliferation and hæmorrhages. The liver also shows degeneration, but its gross appearance may be quite variable, at times being fatty, or of a dark mahogany colour. Follis[31] argues that in view of the liver changes it is probable that other essential nutrients are deficient in this condition, possibly vitamin K, which might account for the hæmorrhages.

It is evident, therefore, that there are variations in the pathological findings produced by aneurin deficient diets in different types of animals. Furthermore, the rapidity of production of B_1 deficiency in the same species appears to be of considerable importance in determining the terminal pathological picture; thus a quick depletion of the vitamin minimises the possibility of compensatory changes occurring in the animal.

Agents such as the naturally occurring thiaminases would be expected to produce a more complete and acute aneurin depletion, since they would inactivate both the aneurin in the diet and possibly that part produced by microbial synthesis in the alimentary tract. It seems to us that an active enzyme preparation from bracken would be a very effective method of rendering a mixed diet devoid of aneurin, and might be used for this purpose in experimental studies on vitamin B_1 deficiency.

In considering all the possible effects of thiaminase-containing plants on farm animals, it would be dangerous, in our opinion, to assume, without proof, that this enzyme is the only nutritionally harmful factor present in the whole plant.

Summary

(1) Typical "bracken staggers" in the horse has been reproduced experimentally by the feeding of a bracken-hay diet. Clinical records, hæmatological and biochemical observations made during the course of the work are recorded and discussed.

(2) This condition in the horse exemplifies the symptoms which are characteristic of avitaminosis B_1. Clinically and pathologically cardiac involvement is prominent. The blood aneurin level is much depressed, and the pyruvic acid concentration is markedly increased, both being well-recognised biochemical lesions in aneurin deficiency.

(3) Aneurin therapy, if commenced before the condition is too far advanced, is successful in curing the animal.

(4) The effect of feeding bracken to the horse seems to be similar to the action of this plant on the rat. Both phenomena are adequately explained by our previous finding that a thiaminase is present in the bracken, which by virtue

XUM

of its property of splitting aneurin into its components denies this essential intact vitamin to the animal.

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REFERENCES

(1) White, J. (1812): "A Treatise on Veterinary Medicine," Vols. 1 and 3 (London).
(2) Wood, J. A. (1757): "Treatise of Farriery" (London).
(3) Williams, W. (1897): "The Principles and Practice of Veterinary Medicine" (Baillière, Tindall & Cox, London).
(4) Muller, H. (1897): "Landwirthschaftliche Giftlehre" (cited in Lander's "Veterinary Toxicology": publishers, Baillière, Tindall & Cox, London. 1926 edition.).
(5) Hadwen, S., and Bruce, E. A. (1920): *Brit. Vet. Jl., 76,* 98.
(6) Swenerton, L. D. (1920): Private communication, cited by Hadwen and Bruce.
(7) Thomas, T. R. (1950): Private communication.
(8) Grieg Russell (1949): Private communication.
(9) Weswig, P. H., Freed, A. M., and Haag, J. R. (1946): *Jl. Biol. Chem., 165,* 737.
(10) Evans, W. C., and Evans, E. T. R. (1949): *Brit. Vet. Jl., 105,* 175.
(11) Thomas, B., and Walker, H. F. (1949): *Jl. Soc. Chem. Ind., 68,* 6.
(12) Evans, W. C., Jones, N. R., and Evans, R. A. (1950): *Proc. Biochem. Soc.,* March 24, xii.
(13) Yudkin, W. (1949): *Physiol. Rev., 29,* 389.
(14) Roberts, H. E., Evans, E. T. R., and Evans, W. C. (1949): *Vet. Rec., 11,* 549.
(15) Sinclair, H. M. (1938): *Biochem. Jl., 32,* 2185.
(16) Harris, L. J., and Wang, Y. L. (1941): *Biochem. Jl., 35,* 1050.
(17) "Official Methods of Analysis of the International Society of Leather Trades Chemists" (1938). Publishers, A. Harvey, London.
(18) Friedmann, T. E., and Haugen, Gladys E. (1943): *Jl. Biol. Chem., 147,* 415.
(19) Carpenter, K. J., Phillipson, A. T., and Thomson, W. (1950): *Brit. Vet. Jl.,* 106, 292.
(20) Holman, H. H. (1944): "Clinical Hæmatology" Section in "Diagnostic Methods in Veterinary Medicine," by G. F. Boddie (publishers, Oliver & Boyd, London).
(21) Todd, J. C., and Sanford, A. H. (1944): "Clinical Diagnosis by Laboratory Methods" (publishers, Saunders & Co., Philadelphia).
(22) Phillips, R. A., Van-Slyke, D. D., Dole, V. P., Emerson, K., Hamilton, P. B., and Archibald, R. M. (1945): "Copper Sulphate Method for Measuring Specific Gravity of Whole Blood and Plasma" (Josiah Macy, Jr., Foundation, New York).
(23) Evans, E. T. Rees (1950): Unpublished data.
(24) Naito, K., Shimanura, T., and Kuwabara, K. (1925): Third Report, Japanese Govt. Inst. Vet. Research, p. 51.
(25) Carlstrom, B., and Hjarre, A. (1939): *Tierernahrung, 11,* 121.
(26) Carroll, F. D., Goss, H., and Howell, C. E. (1949): *Jl. Animal Sc., 8,* 290.
(27) McElroy, L. W., and Goss, H. (1940): *Jl. Nutrition, 21,* 163.
(28) Carroll, F. D. (1950): *Jl. Animal Sc., 9,* 139.
(29) Carlstrom, B., and Hjarre, A. (1938): *Skand. Vet., 28,* 517.
(30) Svanberg, O. (1938): *Lantbrukshogsk. Ann., 5,* 355.
(31) Follis, R. H. (1948): "The Pathology of Nutritional Disease," pp. 145-158 (publishers, Blackwell Scientific Publishers, Oxford).
(32) Wintrobe, M. M., Stein, H. T., Miller, M. H., Follis, R. H., Jr., Nagjar, V., and Humphreys, S. (1942): *Bull. Johns Hopkins Hosp., 71,* 14.
(33) Pantridge, J. E. (1948): *Brit. Heart Jl., 10,* 252.
(34) Evans, C. A., Carlson, W. E., and Green, R. G. (1942): *Am. Jl. Path., 18,* 79.

XUM

STUDIES ON CATARRHAL ENDOMETRITIS IN THE BOVINE

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An Introductory Clinical Survey of the Disease Group with Some Bacteriological Control *(Concluded)*

Trials of Treatment Methods

ABOUT 30 treatment trials were wasted on cases which had already recovered naturally or apparently been cured, as shown by the disappearance of organism, but which still showed clinical symptoms of reduced severity at the second visit. Exclusive of these, 66 trials remain to be tabulated where the disease was fully developed with organisms present at the first day of treatment. Some of these were carried out in cases which had developed gross lesions, so that there was, in fact, no selection of good treatment risks, all cases receiving trials even if prognosis appeared hopeless at the first visit. The trials involved all 17 animals in the third order, and 11 of those in the second.

Five types of response to treatment were seen—no apparent benefit; slight, transient benefit; marked, lasting benefit; "bacteriological recovery"; and true recovery with subsequent conception. Rigid definitions of responses have been used for allocating the results of the individual trials among these types. The requirements for that termed "bacteriological recovery" may be detailed here as an example; full particulars of the other definitions have been omitted to save space. A case of bacteriological recovery after, or in the absence of, treatment ran an identical course to those of true recovery with conception up to the occasion of the first service. This was never permitted unless the uterus had recovered its normal size and tone; organisms, discharge and symptoms of cervicitis had disappeared, and ovarian cycle had returned. From this point on, "bacteriological recoveries" differed by their failure over several months to conceive to repeated service, remaining meanwhile clinically normal by the usual criteria. In four cases the organism and discharge eventually returned after months of absence. In another four, including two of those which reached this stage naturally without treatment intervening, the organism was never found to reappear, but a scanty discharge, sterile by the culture methods used, was usually obvious for a day after service or artificial insemination.

An obvious criticism of the work expressed in Table III is that some treatments are heavily overloaded at the expense of others. For instance, the excessive number of trials with iodine represent, usually, treatments by general practitioners, which did not produce any improvement in the disease course, with the result that the cases came to the hands of the research clinician.

It is highly likely that a true figure for iodine would, at all events, condemn this treatment much less conclusively, if only because a proportion of I*b* cases has been proved to resolve in the absence of any treatment. Many cases which

TABLE II

Treatment Trials of Group I A

Treatment trial No.	Case No.	Cervical sample nature and culture result. 1.	2.	3.	4.	Treatment applied.	Consequence.
1	H 18	Moderate, mixed pus and mucus. Sterile.	Copious and purulent. Sterile.	Copious, mixed. Few strepto- and staphylococci.	Moderate, mainly purulent. Few moulds only.	Propamidine.	No good effect; uterus at end of trial much more enlarged, filling with pus. Cyclic impairment evident.
2	H 18	—	Moderate, mainly purulent. Few moulds only.	Trace clear mucus only. Sterile.	Copious œstral mucus. Sterile.	Endocrine. Corpus luteum enucleation.	Cycle at once restored; œstrus within 3 days and evacuation of all purulent content from uterus. Conception to second service.
3	H 24	Copious, mainly purulent. Sterile.	Moderate, mainly purulent. Sterile.	Small quantity cloudy mucus only. Few staphylococci.	Moderate quantity clear mucus. Sterile.	Sulphapyridine.	Impairment of cycle still clearly evident at conclusion. Discharge apparently "cured" (relapse later).
4	H 24	—	Moderate, clear mucus. Sterile.	Scanty, clear mucus. Few *Bacterium coli*.	Trace clear mucus. Not cultured.	Endocrine. 40 mgm. stilbœstrol with 1,500 i.u. pregnant mare's serum.	Cycle restored, œstrus within 9 days (some discharge following service, cf. Trial 2). Conception third service.
5	H 33	Copious, purulent. Not cultured. January 18.	Copious, purulent. Sterile. March 21.	Copious, purulent. Sterile. March 29.	—	Control.	Complete ovarian quiescence for 5 months; discharging during the last 3 of these.
6	H 33	—	Three days after œstrus. Copious, purulent. Sterile.	17 days after œstrus. Much scantier and mixed with mucus. Not cultured.	Scanty, blood-stained mucus Sterile.	"Endocrine." Spontaneous occurrence of œstrus.	Cycle regular thereafter; conception first service.
7	136	Copious, purulent. Not cultured.	Copious, purulent. Few anthracoids and staphylococci.	—	—	Control.	Two readings 10 months apart; during these uterus steadily filling with pus to ultimate size equivalent 3 months' pregnancy.
8	136	Copious, purulent. Few anthracoids and non-hæmolytic staphylococci. January 26.	Copious, purulent. Day before œstrus. February 8.	—	Copious, clear mucus. 6 weeks after first œstrus.	"Endocrine." Spontaneous occurrence of œstrus.	Regular cycle and conception at second service. Uterus thus completely recovered within 6 weeks.

improved following application of iodine by general practitioners would never have been seen by the research worker. Nevertheless, these trial results do supplement the similar results from the untreated controls, as evidence that the

TABLE III

Responses to Treatment in Sub-group B.

Type of treatment	Total trials	RESPONSES: No apparent benefit	Slight transient benefit	Marked lasting benefit	Bacteriological recovery	True recovery with conception
Iodine	17	17	—	—	—	—
Sulphapyridine ...	2	2	—	—	—	—
Control	12	6	—	1	1	4
Sulphanilamide ...	7	2	2	3	—	—
Propamidine ...	9	—	2	2	2	3
Endocrine	14	—	3	4	3	4
Sulphanilamide with Endocrine	1	—	—	—	—	1
Propamidine with Endocrine	4	—	2	—	1	1
	66	27	9	10	7	13

tendency of the disease to persist over many weeks unchanged is exceedingly strong. Too frequently these iodine failures were put on to propamidine or sulphanilamide treatment at once, instead of sulphapyridine or control interval. It early appeared that the former treatments had a specific therapeutic action, often dramatic, and the necessity often arose to bring about immediate improvement in a case with one of these as the preferable alternative to losing access to it altogether—another of the disadvantages inseparable from field conditions.

No fallacy comparable with that probable in the iodine results is, on the other hand, obvious in the pronounced indication given by Table III that intrauterine treatment with propamidine or sulphanilamide, and systemic endocrine treatment, do actually exert a therapeutic influence on the disease course. Table IV illustrates the apparent rapidity and thoroughness of this influence in the case of propamidine.

Thus in all these propamidine trials but one, by the last day of treatment the organism had disappeared, either permanently, or at least for a period of weeks, from the discharge where it had two days previously been abundant, and without exception there was at this stage an evident improvement, usually quite marked, in the macroscopic character of the discharge. Similar direct evidence of disinfectant activity by the irrigations was provided by five of the sulphanilamide treatment trials, and by the five trials where sulphanilamide or propamidine were used in conjunction with endocrine treatment—a final

XUM

total of 19 trials giving such evidence. In fact, so far as these two drugs were concerned, a measure of proof was provided, for the first time, to justify the therapeutic theories long held, without experimental support, by Albrechtsen and the successors of his school concerning the action of uterine irrigants in general. But in the case of iodine, the drug for irrigation which Albrechtsen particularly advocated, this support was not forthcoming from the present study. Of the 17 animals in the third order, nine could be considered cured on evidence of this nature, six made "bacteriological recoveries," and two improved considerably but were slaughtered without the possibility of autopsy, one being a Jöhne's disease casualty.

Discussion

Prognosis for the sub-group must always be considered guarded; though it is probable that the true proportion of natural recoveries is higher than the 22.5 per cent revealed by the survey, three of these cases attest that the recovery may be "bacteriological" only, not completely functional. The proportions of cases forming gross lesions—35 per cent—and of those persisting for some time without these up to the adoption of treatment—42.5 per cent—may bear a true relation to one another. As the results of the trials do seem to provide evidence that certain treatments have in fact a therapeutic influence on the disease course, their application must be held to be economically justifiable; 25 of the 40 cases found became hopelessly infertile, most of them when these types of treatment were not applied at the stages which appear to be most appropriate. The remaining 15 cases recovered and conceived again.

One case record, No. H 27, exemplifies how both irrigant and endocrine factors in treatment may seem necessary to bring about cure. The first treatment, an endocrine one, applied to this cow converted closed pyometra to a catarrhal endometritis, which still existed without relapse a month after the treatment — "*marked lasting benefit.*" A disinfectant irrigation trial with sulphanilamide was then applied, which rapidly appeared to dispose of the organism and cause the uterus to return to normal—"*true cure with conception.*"

During the introductory survey, four *C. pyogenes* cases, additional to the 40 fully studied and dealt with above, were encountered. One appeared to be another example of "bacteriological recovery" in the absence of treatment. The other three later received closer observation.

A third but minor sub-group—C—includes Group I cases clinically identical with Sub-group B but from which *Corynebacterium pyogenes* was not recovered.

This sub-group includes the cases of only five animals. In three, serial Nos. H 45, H 54, and G 8, a copious mucopurulent discharge, with characteristic *C. pyogenes* odour, was present at three weeks *post-partum*; culture, however, yielded only *Bact. coli* in each case, with a few streptococci and staphylococci also in H 45. The animals progressively improved in the absence of treatment, became clinically normal, and held to service. The case of G 11 was similar, except that the first sample was only taken 10 weeks *post-partum*, during which time the cow had continued anœstrous, and contained *Proteus* only. The subsequent history was not one of complete functional, but only of "bacteriological,"

XUM

TABLE IV

Treatment Trials with Propa

Treatment Trial No.	Case No.	Standing of case before trial.	Cervical Sample, Natural and Cu	
			1	2
1	H10	Discharging condition persisting 14 months, withstanding routine iodine treatment.	Copious, purulent; innumerable *C. pyogenes*; odour +++	Copious, purulent; innumerable *C. pyogenes*; odour +++
2	H13	Discharging condition persisting 4 weeks in absence of treatment.	Copious, purulent; odour +; innumerable *C. pyogenes.*	Copious, purulent; odour +; innumerable *C. pyogenes*, some *Bact. coli.*
3	43	Discharging condition persisting 2 months in absence of treatment. Uterine wall abscess forming when irrigations begun.	Necrotic material, many blood clots, little pus; odour ++++; innumerable *C. pyogenes.*	Liquid bloodstained necrotic material; odour ++++; innumerable *C. pyogenes*, some *Bact. coli* and streptococci.
4	H44	Discharging condition persisting 7 months and withstanding routine iodine treatment.	Copious, purulent, sanguineous; odour +++; innumerable *C. pyogenes.*	Copious, purulent; odour +++; innumerable *C. pyogenes.*
5	H44	Discharging condition persisting 4 months after apparent reinfection, endocrine treatment having failed.	Copious, purulent; odour +++; not cultured.	Copious, purulent; odour +++; innumerable *C. pyogenes.*
6	134	Discharging condition persisting 3 months in absence of treatment.	Copious, purulent; odour ++; innumerable *C. pyogenes;* some hæmolytic staphylococci.	Copious, purulent; odour +; innumerable *C. pyogenes.*
7	66	Discharging condition 3 weeks *post-partum* and treated immediately.	Copious brown fluid, lochial discharge; odour +++; innumerable *C. pyogenes*; many "green" streptococci.	Copious, purulent; odour ++; innumerable *C. pyogenes.*
8	H30	Discharging condition 3 weeks *post-partum*, withstanding iodine 10 days before.	Copious, purulent; odour +; innumerable *C. pyogenes*; few hæmolytic staphylococci.	As 1
9	G3	Discharging condition persisting 7 weeks, withstanding routine iodine treatment.	Moderate, mainly purulent, some mucus; odour +; innumerable *C. pyogenes.*	Copious, mixed mucopurulent; innumerable *C. pyogenes.*

IV

Propamidine Irrigation

and Culture Result

3	4	Consequence
Copious, now contains proportion of mucus; no odour; numerous *C. pyogenes.*	Copious, purulent; innumerable *C. pyogenes;* odour ++	"Slight transient benefit." Bacteriological recovery on endocrine treatment seven weeks after this trial.
Copious dirty mucus, pus-free; few "green" streptococci; many *Bact. coli.*	Moderate mucus, pus-free; sterile.	"Slight transient benefit." Bilateral pyometra at time of No. 4 sample, though organ little enlarged at conclusion of treatment. Organisms again recovered during an endocrine treatment which resulted in bacteriological recovery.
Mixed muco-purulent discharge containing polymorphs; no odour; *Bact. coli* and *streptococci* only.	Bloodstained, with clots and debris; innumerable *Bact. coli* and some anthracoids.	"Marked lasting benefit." *C. pyogenes* absent from discharges for more than four weeks, reappearing seven weeks after treatment.
Copious mucus with some pus flakes; no odour; sterile.	Scanty rather cloudy fluid mucus; no odour; sterile.	"Bacteriological recovery." Clinically normal for twelve weeks after treatment. Appearance of reinfection from the bull on service then ensuing.
Mixed muco-purulent but mainly mucus; no odour; non-hæmolytic; staphylococci only.	(14 days after close of treatment) Vagina, cervix clean and dry; few *Bact. coli* on swab.	"Marked (lasting) benefit." Apparent bacteriological recovery but animal slaughtered 14 days after close of treatment.
Mixed pus and mucus; no odour; staphylococci only.	Scanty, purulent; no odour; many coliforms only.	"Bacteriological recovery." Clinically normal for five months after treatment, including two fruitless services. Then apparent reinfection from bull.
Purulent; no odour; many *Proteus* only.	Scanty clear mucus; sterile.	"True recovery with conception," holding to first service.
Moderate mixed muco-purulent; sterile.	Scanty cloudy mucus; innumerable *Bact. coli,* streptococci, staphylococci.	"True recovery with conception," holding to first service.
Scanty fluid mucus; no odour; not cultured.	Scanty clear mucus; innumerable "green" streptococci.	"True recovery with conception," holding to first service.

recovery. Case 152 produced odorous discharges of the I*b* type at two consecutive visits, neither containing organisms. A course of propamidine was given, which appeared to remedy the condition, and the animal afterwards conceived. In view of the findings in two *C. pyogenes*-positive cows, where odour remained perceptible after organisms had disappeared from the discharge, it seems probable that the animals of sub-group C were observed at a stage in their natural recovery from disease associated with *C. pyogenes,* just after the disappearance of the organisms. There exists also the possibility that organisms were present *in utero* though not recoverable *ex vagina,* as was probably the case in the early stages of one already mentioned case, where in the end diphtheroids were demonstrated, though they were not recovered from the initial sample.

Group II: Non-specific Continuous Catarrh Under Normal Ovarian Conditions

Group II includes cases showing little or no evidence of pathological cyclic impairment; discharge includes pus and mucus in similar proportions, is relatively scanty; and bacteriological findings are inconclusive.

Sub-group A includes Group II cases where the discharge has been continuous from the time of calving, the animal having failed to "clean up" normally. Only in the cases of longer standing has the œstrous cycle returned, but it does so within normal limits and then tends to be regular.

The sub-group comprises 14 animals on which 18 treatment trials were carried out, including three controls.

The clinical picture at the outset is rather consistently one of an enlarged and somewhat atonic uterus showing undue delay in involution, with a mucous discharge containing a proportion of pus, usually in isolated flakes. Four of the cases followed placental retention; in one of the others there was obvious abnormality at parturition—dystokia with breech presentation; in all, over one-third with parturition trauma. Bacteriological culture readings are available from 25 initial and first treatment day plates, from as many discharge samples, of which 18 included some pus. Eight of these were sterile, nine yielded a growth of a single organism, and eight yielded two, or occasionally three, different organisms. *Bacterium coli* occurred eight times on the 23 plates, non-hæmolytic staphylococci six times, and α-hæmolytic streptococci eight times; *Proteus* four times. The numbers of organisms were usually small or moderate, but in two instances the plate yielded innumerable *Bacterium coli*; this finding never recurred in the individual case history, but in case No. H 26 innumerable α-hæmolytic streptococci were consistently recovered during its course, the sole example of any bacteriological continuity in the sub-group. Three cases had continued to show disease for 15-26 weeks when first seen, and four more had shown it for from 6-7 weeks, so that the condition in over a third of the cases was still in existence more than 6 weeks after calving. Departures from normal ovarian physiology were shown by four cases, two showing a subœstrous and sluggish tendency in their cycles, which returned within normal limits of time, while another, soon after the first ovulation, remained in a state of recurrent cyst formation for three weeks before a normal cycle continued. The last such

XUM

case showed completely quiescent ovaries for 120 days post-partum, but this animal was throughout the period gravely ill, with traumatic pericarditis.

From the treatment and prognosis aspects, the tables show a pronounced tendency for the cases to return progressively though gradually to a condition of normal health. Culture readings are available from 24 last treatment day and final discharge samples. Eight were sterile, eight yielded mixed growths, and eight growths of a single organism. α-hæmolytic streptococci occurred 10 times, *Bacterium coli* eight times, non-hæmolytic staphylococci seven times, and *Proteus* was not found. Again the density of microbes was usually low, but *Bacterium coli* was " innumerable " three times. The findings are, in fact, very similar to those before treatment was undertaken (the occurrence of *Proteus* was limited to initial samples; it was recovered from none collected on the first treatment day). These results when tabulated thus show no relationships between nature and number of organisms, character of discharge, and effects of treatment, contrasting remarkably with the results from Group I, where such relationships are most evident. However, only 11 of the 24 samples contained elements of pus —evidence of the progression towards recovery with the lapse of time. In general the bacteriological results were inconclusive, the organisms found resembling the normal flora of the healthy state in nature and number, or in the case of *Bacterium coli,* being quite possibly contaminants from the bowel. As a basis for conclusions the treatment trials are quite inadequate, but the results suggest that none of the methods has any influence on the disease course. The allocation of trials by rota was carried out over Group II as a whole, with the result that in Sub-group A, five of the 14 trials happened to be made with propamidine. The cervical sample collected on the last day of each of these, without exception, was markedly more copious, and contained a higher proportion of pus, than was observed in any other samples collected from the animals of this sub-group. Three of these five purulent samples were sterile, and the others contained only a few bacteria. The earlier samples from these cases had been scanty, and three of the first treatment day samples, also, were sterile. It is possible that a specific effect of the drug on the tissues is concerned here. Disregarding these five samples, only six of the last treatment day and final samples contained pus.

The proportion of cases conceiving to first service without loss of time (within 90 days post-partum) was 43 per cent—six animals. Three conceived to first service only after longer intervals, two on account of the persistence of the disease and one owing to a subœstrous tendency in its cycle following uterine resolution. Most of the remainder as it happened became casualties within a few weeks or months for reasons not connected with their breeding powers.

In consideration of these results the prognosis for the sub-group seems good, but the range of cases is a small one.

Group II (continued): " Malignant " Catarrh Observed after Trichomoniasis

Sub-group B includes Group II cases where the discharge has not been in evidence from calving onwards, but has arisen later and is associated with a regular œstrous cycle, the animals repeatedly returning to service. Discharge is relatively copious, though much less so than in Group I, and the prognosis is bad.

The cases were peculiar in being derived from three herds only, nine of the 10 cows belonging to two herds in which there was recent history of severe Trichomoniasis epizootics. In herd A the cases began to develop after this disease was considered controlled, the affected animals being those which had calved normally following service by the infected bull, and which were then irrigated with iodine to clear up possible infection. Symptoms appeared weeks or months later following this treatment. In herd B, however, the discharge began when the epizootic was at its height, and continued for certainly 4 months afterwards, the cases thus forming a hard core of troublesome animals long after most cows affected by the epizootic had conceived afresh. The discharge was usually sufficiently copious to appear very obviously to the exterior and soil the tail, but there was no tendency for it to accumulate in the uterus or vagina. There was no direct connection established between the tenth case and Trichomoniasis, but the case occurred in an area where this infection is rife. So far as can be ascertained, no case arose less than 10 weeks *post-partum,* implying a minimum interval of 7 weeks without vaginal discharge of any kind; symptoms then appeared, in some cases without service having been permitted and in others following service.

Details are available of only 20 sets of cervical samples. Cultures were made from all 10 of the initial and first treatment day sets, three proving sterile, two yielding a single organism, and five mixed growths. *Bacterium coli* occurred four times in small to moderate numbers, as did α-hæmolytic streptococci, five times. These latter organisms were "innumerable" on one plate. Non-hæmolytic staphylococci occurred in small numbers twice, and anthracoids once. Macroscopically five samples were copious and mixed muco-purulent, with mucus predominating. Four were moderate or scanty and muco-purulent, and at the tenth sampling a "clean" vagina was found. Of the last treatment day and final sets, cultures were not made from three samples of clear mucus. Three samples were sterile, two yielded a single organism, and two mixed growths. *Bacterium coli* occurred three times in small to moderate numbers and was once "innumerable." α-hæmolytic streptococci occurred twice, non-hæmolytic staphylococci four times, both organisms in small numbers; diphtheroids, not *C. pyogenes,* occurred once. Macroscopically two samples were copious and muco-purulent, three moderate or scanty and muco-purulent, three with moderate or scanty clear or cloudy mucus only, and two "clean" vaginæ were found. The bacteriological findings thus resemble those of the previous sub-group, differing little before and after treatment and resembling those from healthy cattle. Fourteen treatment trials were made, including four controls; six irrigation treatments had no effect in altering the clinical picture; there was improvement after four, but two controls improved after similar lapses of time. Results give the impression that clinical symptoms tend to disappear in the absence of, or despite, early treatment, after an average duration of 4 to 5 months. Afterwards two of the animals conceived again, one was destroyed without trial of service, while the other seven failed to conceive despite repeated service, and were therefore slaughtered.

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Group II (continued): "Benign" Catarrh after Repeated Failure to Conceive

Sub-group C includes cases where the discharge has arisen later than calving, is associated with a regular œstrous cycle, the animals repeatedly returning to service. Discharge is scanty in quantity and prognosis is good.

The first three cases showed no evidence clinically detectable of reproductive endocrine dysfunction. One was observed in Staffordshire and two seen eight miles apart in Sussex, but the histories have so many points in common that they demand consideration as a unit. The owners all reported a discharge visible to the exterior; twice this was seen between heats and once it was thought to follow service. On clinical examination the findings *per rectum* indicated a possible slight endometritis, but nothing that could be regarded as an abnormal discharge was obtainable from the cervix, and the cows appeared clinically normal in all other respects. In one case the œstrous cycle was re-set by corpus luteum expulsion; in the other two further service was advised without therapeutic intervention. Each animal was then served three times at successive heats without conception resulting. Repeated vaginal examinations during this period revealed a scanty mucous discharge with slight purulent admixture on half the occasions; the other half gave the findings of normal health. Cultures were made from a total of eight samples, including swabs when the vagina was clean. Their results resembled those from the previous two sub-groups. There was no correlation at all possible between the number and type of organisms found and the nature or quantity of discharge. Neither did the bacteriological picture appear to be affected in any way by the local treatment which was eventually applied, following the third return to service. This took the form of a course of iodine irrigations. Slight muco-purulent discharges were found still in two cows up to a week after the last irrigation, following which the vaginæ remained consistently "clean" and all three animals conceived to either the first or second subsequent service or insemination. (This result was sufficiently dramatic to convey the impression that it was the true consequence of the treatment employed.)

These cases appear to be typical of the *first-degree* endometritis of Richter's classification, and thus scarcely of a true *catarrhal* disease, but in view of the continued reappearance of abnormal discharge, without regard to the incidence of heat periods, it is thought probable that the discharge had, in fact, a continuous tendency, but was too scanty in quantity for samples to be obtainable at every examination. The clinical signs, prognosis, and response to treatment correspond exactly to the type of case which has received so much attention in the writings of Nielsen.[9] Since the treatment employed by him, and later recommended by the N.V.M.A. Survey Committee, 1941, has become a standard routine with most general practitioners among cattle, it may be supposed that these cases are very much more common than the present study indicates, but that the response to the routine treatment is in general as good as it was with these three animals. Accordingly the great majority of cases are not brought to the attention of specialist consultants.

XUM

In five further cases evidence of reproductive endocrine dysfunction was detectable clinically, though falling short of complete or prolonged impairment of the cycle.

Otherwise they resembled the first three cases, both in the consistent complaint of repeated returns to service and in the scanty quantity and rather intermittent appearance of the discharge. Regarding the first three cases, it was stated that service was tried, but in vain, while the untreated animals were under observation, and appeared almost clinically normal. Only after treatment was fertility restored. However, with the last five, practical difficulties made it impossible to demonstrate such continued infertility after endometritis symptoms obvious to the owner had spontaneously disappeared.

Some treatment was, therefore, usually attempted after the cessation of discharge and return of the uterus to normal, as judged *per rectum* without trial of service intervening. In the case of No. H 12, symptoms suggesting delay of about 40 hours in ovulation were present, along with those of endometritis, and this possibility was confirmed more strongly at subsequent heats when the latter had resolved. Treatment took the form of appropriately delayed insemination, and conception resulted from the second heat at which this was done. In the next two cases there was subœstrus, or more probably a complete failure of cycle, of 3-4 weeks' duration; both conceived to service at the first therapeutically-induced heat. The existence of disease was established in the fourth case with failure to ovulate four days after heat, but its course could not be followed further, while the fifth showed a clearly-defined condition of cystic ovarian disease, together with endometritic symptoms, which both resolved spontaneously and simultaneously. In fact, once again in all the treated cases conception quickly followed therapeutic interference.

A survey of all the cases in Sub-group C, having regard to the therapeutic interference undertaken, reveals a clinical entity where the impairment of reproductive function is only loosely associated with the undeniable appearance, at some stage, of a scanty discharge and of loss of uterine tone. Correlation is, remarkably enough, much closer between recovery of conceptive power, and therapeutic interference of a nature calculated to affect the reproductive endocrine system, than it is between functional recovery and the return of the uterus to normal conditions, as judged by the usual clinical standards. These findings in respect of correlation are in complete contrast to the results obtained in all other types of endometritis to far considered in this survey.

The bacteriological results were comparable with those already recorded in Group II. On several occasions it was possible, in animals of this sub-group, actually to watch small quantities of pus unmixed with mucus being extruded through the cervix. This usually followed massage of the uterus per rectum, a previous vaginal examination having yielded no material.

Post-œstral Intermittent Catarrh

Sub-group D includes Group II cases where the discharge is not continuous, but is usually in evidence only for a short period after heat, usually when service

has been allowed. Œstrus recurs regularly and the presence of discharge is not necessarily accompanied by infertility.

The condition in which the first two cases, serial Nos. H 42 and H 43, were found was identical clinically with that seen in those cows of Group I*b* in which "bacteriological recovery" had taken place; they were observed respectively for periods of 4 and 2 months, during which they were regularly served. Discharge, mainly purulent and in small quantity, was usually present, as a rule from about the second to not beyond the fourth day after service. Cultures were made from only one sample from each cow, yielding respectively a few *Bacterium coli* and α-hæmolytic streptococci, and a sterile plate. Both animals were eventually sent for slaughter as hopelessly infertile. As the earlier histories of these cases, as recounted both by the owner and the general practitioner, appeared typical of Group I*b*, it seems most reasonable to suppose that in these particular instances, as probably in a high proportion of others that might come within the definition, they are in fact the end-results of *C. pyogenes* cases which have progressed only as far as bacteriological recovery.

Next come six animals in which the evident condition apparently caused no interference with a normal conception ratio. The first failed to conceive despite repeated services showing discharge after each; another conceived at the second service of two allowed during the observation period, discharge following both. Between these services intervened an œstrus when no discharge was produced, in the absence of service. The remaining 4 cases were observed over a single œstrus with service, which invariably resulted in conception. Discharges were always mucus, with a rather heavy admixture of pus, and approached in their rather large quantity those of the post-Trichomonal series of cases. Cultures were made from five of these samples, revealing normal-type flora. The pregnancies were normal and no discharge was detectable at later visits. That an after-service discharge need not interfere with conception has already been recorded both by Albrechtsen[1] and Nielsen.[9]

Three cases were encountered in heifers, which came on heat three weeks after the service to which they later proved to have conceived. The discharges were similar in most respects to those found in the previous six cases.

Such cases are suggestive of a cervicitis which does not extend cranially beyond the internal os, or in some other less obvious manner tends not to preclude conception. The case-history of serial No. H 1, which continued to discharge to some extent, certainly up to the day of fertile service, is suggestive of an original endometritis with cervicitis, of which the former resolved first. Gould[5] refers to the condition of an open discharging cervix during pregnancy, and Murray[8] has recorded his impression that such cases are more likely to abort than are those with a normal cervical seal.

"Myxometra"

Group III. Discharge is copious and continuous, but is free from pus, and consists entirely of clear, very fluid, mucus. There is no pathological impairment of the œstrous cycle.

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This group contains only a single case, exhibiting very distinctive symptoms which must inevitably place it in a class by itself. The animal, serial No. H 5, calved and went on normally until served 112 days *post-partum*. A copious discharge of mucus was from then on visible to the exterior by the attendant several times weekly; the animal was not served again but received a treatment trial of iodine from the general practitioner, which did not affect the condition. When first seen there was no uterine enlargement, but the walls were quite without tone and felt extremely fragile, meriting the adjective "brittle." At each of four vaginal examinations, spread over six weeks, from a pint to a quart of the watery mucous discharge was recovered. During this period the uterine tone steadily improved and this process had begun before a treatment trial with propamidine was carried out, which had no effect on the discharge. At the first day of treatment visit, no discharge or sample of vaginal secretion could be obtained, though it had been copious a fortnight earlier, and was consistently so for 4 weeks, beginning with the last day sampling. The bacteriological findings were small numbers of streptococci and staphylococci at the initial and last day samplings, and large numbers of *Bacterium coli* at all visits. Just after this observation period, artificial insemination was tried without success. Further visits to the case proved impracticable, but it was reported that the animal conceived to a service in March, 9 months after the discharge first appeared.

The clinical picture which case No. H 5 presents recalls at once the condition of "metropathia" described from German material by Wille, 1944.[12] He found this syndrome only in high-yielding cows, running a course usually for about 5 months *post-partum*, after which it resolved naturally. The chief symptom was the persistent production of an œstrous type of slimy discharge, which might be retained in the uterus to produce myxometra, or in the less severe cases showing visible heats, voided to the exterior. Rarely, conception was possible during the condition, when experience showed that placental œdema, early abortion or eventual parturition trauma were to be feared. (Wille attributes "metropathia" to an upset of the nervous and hormonal mechanisms controlling reproduction, and considers it a probable forerunner of true endometritis involving pus production and the multiplication of organisms.)

Summary and Conclusions

The aim was to make the nearest possible approach to obtaining a true cross-section representative of the different types of discharging disease, so investigation was attempted of all such cases, in existence beyond 3 weeks *post-partum*, that could be made available. Eighty-eight studied fully were included in the survey, receiving an average of 12 visits each over 3-4 months, and some evidence is adduced from among 25 other cases, which each received up to only four serial visits. The trial with *C. pyogenes* stock culture filtrate was not extensive enough to indicate definitely whether this preparation had any curative influence on endometritis associated with this organism, but results suggested strongly that in animals so affected clinically the blood antitoxin titre, which appears unaffected in controls treated with the preparation, tends frequently to

XUM

reach a distinctly higher level than is found in normal animals. At the same time this level is very much lower than is found in cases of *C. pyogenes* bone abscesses or mastitis. The suggestion is advanced that no biological preparation is likely to ameliorate clinical endometritis associated with this organism.

Cases were classified into three main groups, according to the macroscopic character of the discharge, and its relationship with the presence or absence of an œstrous cycle. In the first group a cycle was lacking, the disease course was long, and the discharge was copious, being composed mainly of pus; in nearly 10 per cent of the cases this appeared to be essentially sterile, and the prognosis was good. But in over 90 per cent the discharge continued, over a period, to yield *C. pyogenes* in large numbers, and had a characteristic foul smell. Here prognosis was poor; 25 of the 40 cases found remained incurably infertile. However, 66 treatment trials, to some extent controlled, provided a considerable volume of evidence, that both systemic endocrine treatment, aimed at restoration of cycle, and certain types of local irrigation not including iodine, had the power to influence the course of the disease, the good effect being often rapid, and in appearance decisive. The irrigation treatments were shown to act directly through their disinfectant properties. As the only cardinal difference in the clinical picture between the two portions of this group lies in the occurrence of large numbers of *C. pyogenes* in the cases of the second portion, in which prognosis is far graver than in the first, and as recovery coincides with the disappearance of this organism, either naturally or through treatment, of which some forms demonstrably destroy it, the evidence is strong that the activity of *C. pyogenes* is in truth the factor which worsens the prognosis.

In the second group of cases, discharges were scanty to moderate in quantity, containing mixed pus and mucus, and there was little if any impairment of a normal œstrous cycle. Fourteen cases showed a scanty discharge, continuous from the puerperium, five of them after parturition trauma; in these prognosis as a rule was good. Ten cases showed a more copious discharge much later than the puerperium, though not necessarily after service; nine of these constituted "hard cores of trouble," following attempts to control Trichomoniasis epizootics, and prognosis was poor. In all these 24 cases evidence on the effects of treatment was insufficient, but suggested that no form tried had any influence on the course of either type of disease. In a further eight cases discharge was very scanty, and appeared much later than the puerperium, after the failure of repeated service to result in conception. Prognosis was good; following treatment, the restoration of fertility was sufficiently dramatic to convey the impression that it was the true consequence of the treatment employed. This was either frank systemic endocrine therapy, or iodine irrigations, which, as Hignett has shown, can act as a general stimulant to the reproductive endocrine system. The remaining types of discharge case in the group were either thought to be consequences of earlier *C. pyogenes* affection, or else to be associated with no obvious departure from normal breeding efficiency.

The third group included a single animal which produced a copious discharge of completely pus-free mucus. Although in the second group the

bacteriological findings were by no means so frequently negative as in the first 10 per cent of the first group, it is considered that in both these categories the organisms found were seldom, if ever, more than the saprophytic vaginal or uterine flora of normal health, with the findings in which state they agree in nature and number. The greater dilution of the bacteria by the large quantities of discharge which were produced is held to account for the high proportion of sterile samples in the first group. As only just over half of the cases fully studied were seen as they arose, and before treatment by the general practitioners by whom the remainder were referred to the specialist, it seems probable that the representation in the survey of disease types which have a good prognosis, more especially after routine treatment, may be disproportionately small. This category includes all types except the *C. pyogenes*-associated cases in the first group and the post-Trichomonal cases in the second.

Acknowledgments

The writer is much indebted to Mr. B. G. F. Weitz, who carried out a considerable part of the bacteriological analysis and all the serological work; and to Mr. I. G. Shaw for making available the particulars of 23 cases observed by him. He also wishes to thank all those practitioners whose areas yielded clinical material.

REFERENCES

(1) Albrechtsen, J. (1917): "The Sterility of Cows." Chicago.
(2) Cembrowicz, H. (1946): Dissertation. Cambridge.
(3) Dawson, F. (1950): *Vet. Jl.*, 106, 104.
(4) Dawson, F. (1950): Paper in press.
(5) Gould, G. (1941): *Vet. Rec.*, 53, 505, and (1942) ibid., 54, 335.
(6) Kostner, M. (1939): *Wien. Tierarztl. Mschr.*, 22, 609.
(7) Lovell, R. (1937): *Jl. Path. & Bact.*, 45, 339.
(8) Murray, J. (1943): *Vet. Rec.*, 55, 323.
(9) Nielsen, F. (1926): Proceedings of Congress, National Veterinary Medical Association of Great Britain.
(10) Weitz, B. (1947): *Jl. Comp. Path. & Therap.*, 57, 279.
(11) Williams, W. (1943): "Diseases of the Genital Organs in the Domestic Animals," Ithaca, N.Y.
(12) Wille, R. (1944): *Dtsch. Tierarztl. Wschr./Tierarztl. Rdsch.*, 52/50, 310.

ANÆSTHESIA OF THE TEAT OF BOVINES

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THIS clinical note is published in the hope that the product of a little work done concerning local anæsthesia of the teats of bovines, and with particular reference to local anæsthesia for the surgical treatment of lacerated wounds of the teat, will, in certain circumstances, assist in the performance of this not indelicate operation with a greater degree of efficiency, economy, and safety.

Despite an exhaustive research into surgical and medical literature, the writer has found no reference to anæsthesia of the teat of a like nature to that about to be described.

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The germ-thought to inquire into local anæsthesia of the teat was shown a year ago.

In the course of a "busman's holiday" in the Western Isles, my attention was brought to a very critical focus upon the many and varied difficulties and dangers which often confront our colleagues who are practising in areas where from the nature of things clinical practice is performed under very trying and testing conditions.

These difficulties and dangers often arise from the absence of adequate lay assistance to assist in the control of animals, which in many cases are very apprehensive and of nervous temperament, and, also, from the general structure of premises which do not, as a rule, readily lend themselves to the forms of restraint of animals such as may be practised with facility in commercial dairy herd byres.

Among one of the many difficulties discerned was that attending the performance of suture of severely lacerated and deep wounds of the teat of bovines—a surgical exercise which, if it has to be successful, must be done with considerable care, caution, and skill. From which it follows that the greater the degree of local or general anæsthesia obtained, the more readily may we ensure a successful issue.

In casting around in my mind for a satisfactory and safe method of inducing local anæsthesia in the teat, the question of nerve block was considered. A consideration of the nerve supply to the mammary gland and teat proved for our purpose to be most discouraging, e.g., Sisson Grosman, "The Anatomy of the Domestic Animals," third edition, page 620, concerning the mammary gland nerve supply, saith: "Nerves are derived from inguinal nerves and the posterior mesenteric plexus of the sympathetics"; Dukes, "The Physiology of the Domestic Animals," fifth edition, page 660: "Nerves to the inguinal mammæ are derived from the inguinal nerve, which is made up of ventral lumbar branches (usually second and third) and sympathetic fibres from the posterior mesenteric plexus."

The inconstancy of course of the sensory nerve supply and the concurrent difficulty of nerve block under ordinary clinical conditions; nor could it be said that the injection of local anæsthetic into the tissues involved proffered a solution to meet such circumstances as are here under discussion.

It was reasoned that peripheral anæsthesia might be obtained by the injection of a solution of local anæsthetic into the teat canal, and that by diffusion a sufficient degree of anæsthesia to enable stitching to be done. This working hypothesis has been fully justified and supported in practice.

In the most refractory case encountered (R.F. teat, showing a long, lacerated, deep wound, but not involving the lining membrane), the degree of anæsthesia obtained enabled ten stitches to be inserted at leisure and without any manifestation of pain by the animal and without the employment of any restrain of the animal which, previous to the induction of local anæsthesia, was very resentful of handling of the teat. Similar results have been obtained by colleagues who have been good enough to try out the method as introduced.

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Anæsthetics

In earlier work 10 c.c. of 1 per cent solution of cocaine hydrochloride was employed. Later, and despite the somewhat contra-indications observed concerning procaine hydrochloride, equally good results have been obtained with this alternative anæsthetic.

B.P. Codex, 1934: "Procaine hydrochloride has little power of penetration, and is not satisfactory for surface anæsthesia. When injected, its action is rapid and moderately powerful but somewhat transitory . . . with this addition solutions of procaine hydrochloride are regarded as equivalent in activity to cocaine solutions of the same strength." In the work done the evidence contradicts lack of penetration and transitoriness.

Method

When the patient is lactating it is necessary to allow milk to drain off via milk teat-syphon cannula. With milk teat-syphon cannula *in situ*, attach record-type syringe, containing solution of anæsthetic, and inject 10 c.c. of solution slowly. After an interval of five minutes or more, test external surface of teat for anæsthesia.

Anæsthesia has been obtained by the employment of as little as 2 c.c. of 1 per cent cocaine, the solution being injected via the short nozzle of a record-type syringe only. The phenomenon suggests to the writer that the highest degree of sensitivity of the teat occurs at the tip. It has also impressed me with the rapid diffusion of solutions within the teat canal.

However, for routine clinical purposes 10 c.c. has given the most consistent satisfactory results.

ACTINOMYCOSIS IN THE DOG

Report of a Case by C. A. McGAUGHEY, M.R.C.V.S., M.A., M.Sc., D.V.S.M., J. K. BATEMAN, M.R.C.V.S., B.Sc., and P. Z. MACKENZIE.

CLINICAL notes (Bateman and Mackenzie):—

Subject: Greyhound, male, 2 years old.

History: Developed extensive suppurative sinus on the right cheek, the condition spreading up behind the ear and finally bursting out in the middle of the poll.

Treatment: The dog was anæsthetised with nembutal and poll opened up by a longitudinal incision and drainage was established through to the side of the neck.

The wound healed well and the sinus formation appeared to dry up. Several metastatic abscesses appeared on different parts of the body, but these always healed rapidly after bursting. About 16 days after the operation, the wounds on the neck were almost completely healed and the dog was returned from hospital. On the twentieth day, however, signs of pleurisy were detected; the

temperature was 103.5 degrees F., and there was rapid breathing and weak pulse, the chest was dull on percussion of the lower third, but no fluid could be withdrawn by puncture.

Treatment consisted of kaolin poultices to the chest and oral administration of $5\frac{1}{2}$ grammes of M. & B. 693 daily, given in three separate doses. The dog remained bright in appearance and ate well, but continued to lose weight, and the temperature remained elevated; the pulse became weaker. Tuberculin tests (ophthalmic and intradermal) were carried out, but were negative. The dog continued to eat well, but became gradually weaker, and died 11 days after the onset of pleurisy.

Post-mortem Examination: The pleural cavity was filled with dark, blood-stained fluid which contained a great number of small, soft, yellow granules, about the size of millet seeds. The pleural membranes, both parietal and visceral, were much inflamed and thickened; the lungs were almost completely collapsed. In places on the parietal pleura there were small, inflammatory, nodular growths. One of these was situated in the centre of an old scar, between the 5th and 6th ribs on the right side; on cutting through the scar, some blackish material was seen. There seemed to be no communication between the subcutaneous lesions and the cavity. The abdominal organs were normal.

Report of Bacteriological Examination (McGaughey): The only specimen received for examination was a sample of blood-stained pleural exudate containing the small, soft, yellow granules. Some of these were collected and washed gently in saline; smears of crushed granules, stained by Gram's method, revealed a felted mass of slender, Gram-positive filaments, some of which were branching.

Cultures were made in "shake" tubes of melted glucose serum agar and on blood agar plates.

In glucose serum agar "shake" cultures, incubated at 37 degrees C., no growth was visible until 48 hours later, when a band of minute colonies was visible about 10 to 12 mm. below the surface.

On blood agar, there was no growth after aerobic incubation for 24 hours and only a very sparse growth of minute colonies after 48 hours, but it was noticed that if the plates were sealed with plasticine, or incubated in an atmosphere of about 10 per cent CO_2, a more profuse growth resulted.

Blood or serum appeared to be necessary as there was no growth in plain agar; the addition of 1 per cent glucose appeared to improve growth.

Horse Blood Agar: Minute pin-points, grey or pearly colonies which increase in size slowly after four to five days to about 0.5 mm., firmly adherent to the medium and very difficult to emulsify. No hæmolysis. As well as the minute grey colonies, a number of larger (about 1 mm. in diameter) white colonies always appeared on the plates, even if a single small, grey colony is picked off and subcultured. Conversely, subcultures from single white colonies always yielded a mixture of small grey or larger white colonies; however, in films made in the ordinary way, and stained by Gram's method, similar Gram-positive beaded filaments with occasionally swollen ends were seen in both types of colonies.

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Five per cent Serum Broth : Sparse growth of small, granular colonies which adhered to the glass or fell to the bottom; these colonies slowly increased in size, reaching 2 to 3 mm. in diameter. There was no surface growth nor any odour.

Horse Blood Broth : Numerous small granules adhering to the wall of the glass or resting on the deposit of blood; these gradually increased in size. Some lysis of the blood after incubation for a week.

Pathogenicity was tested on two rabbits only, which were inoculated intraperitoneally with a heavy suspension of the culture; no obvious illness developed, but on post-mortem examination two months later some small, firm nodules were found in the omentum.

Remarks

This case occurred in 1938, but the notes thereon were mislaid during World War II. Several similar cases have been reported subsequently, and these will be discussed in the review of the literature on canine actinomycosis (McGaughey, 1951).

The culture isolated resembles that described by Ginsberg and Little (1948) in their case No. 1.

REFERENCES

Ginsberg, A., and Little, A. C. W. (1948) : *Jl. Path. Bact.*, LX, 563.
McGaughey, C. A. (1951) : *Brit. Vet. Jl., 107.*

ABSTRACT OF CURRENT LITERATURE

THE BIOLOGICAL CONTROL OF MOLLUSCS, by A. F. Noseet, Professor, Kharkov Veterinary Institute. Translation and abstract by R. H. A. Merlen. From *Veterinaria,* Moscow, No. 4, 1951.

THE plans formed in Russia for the extensive development of vast regions envisage, in many localities, the construction of large numbers of reservoirs and cisterns for water conservation and for irrigation—the potential danger of these lakes to stock, in that they might harbour the intermediate hosts of parasitic worms has presented itself very forcibly to the minds of those to whom the task of putting the plans into operation has been consigned. With these considerations in mind, Professor Noseet has written a very interesting article on the possibility of controlling the intermediate snail hosts by keeping ducks and geese in the vicinity of these projected reservoirs, and has used for the basis of his paper his practical experience on a farm in his locality.

This farm was situated in a valley in which was a pond of some eight acres in extent, the head of which was overgrown with aquatic plants. The farm stock, cattle and sheep grazed on the surrounding hills and drank water from wells and also from the pond. Before the war a flock of ducks was kept on the pond, and although stock was inspected three times a year for evidence of fluke infestation no such evidence was found, nor were any snails found in the pond or its vicinity.

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During the war the ducks disappeared, and afterwards the farm was restocked (1944-45). In May, 1946, as the result of helminthological examination, widespread evidence of fluke infestation was discovered not only among the stock newly brought on to the farm, but also among animals born on the place. Examination of the pond revealed the presence of small numbers of snails (5-7 per square metre), and others were found in water-carrying hollows below the pond.

Further examinations of the stock carried out in February, May and October, 1947, showed no decline in the level of infestation, and at the same time it was found that the young animals born in 1946 and 1947 showed a high percentage of infestation after 3-4 months at grass.

In 1947, 1948 and 1949, three small reservoirs were constructed on the farm, two of them in the same valley as the original pond and receiving the overflow from it. The first of these ponds became infested with snails the year of its construction. The stock was, however, prevented from drinking from the new ponds and from grazing on their banks as this part of the farm was put down to crops. The infestation of 1946 and 1947 must therefore be ascribed entirely to the influence of the original water supply. The evidence shows that infestation was brought about at pasture and not during the period of stall feeding. No measures were taken against flukes during 1945, 1946 and 1947.

In the autumn of 1947, 68 ducks and 11 geese were brought on to the place, and by 1948 the numbers had risen to 1,000 and 100 respectively.

During the spring of the first half of the summer the birds stayed on the old pond, and only went on to the second when all food had been exhausted. From the summer of 1948 to the end of 1949 repeated examinations failed to reveal the presence of any snails in these ponds. In September, 1949, the ponds were drained to catch the fish, and careful examination of the weeds and mud again showed neither snails nor empty shells. The fourth pond which was constructed had no connection with the original water supply and was not infested with snails.

Examinations conducted three times yearly in 1948 and 1949 revealed that young stock born in 1949, 1948 and 1947 were free from flukes. A number of the older animals harboured the parasites, but they gave indications that the intensity of the infestation was very considerably reduced, apparently indicating a natural weakening of the flukes in the animal organism and a remission in the super-infestation. While at grass in 1949 the cattle drank freely from the pools.

Helminthological examinations and post-mortems on animals killed for food continued to be carried out—in three cattle and three sheep, all born on the farm between 1945 and the first half of 1947—a number of flukes were found, ranging in numbers from 9-38. In a fourth sheep born in the early part of 1948 and slaughtered in 1949 no flukes were found at all.

The inference was drawn that geese and ducks play a most important rôle in combating fluke disease; furthermore, the data seems to indicate that epizootic

XUM

fluke disease runs up to a climax, then after the natural destruction of the snail hosts a balance is set up in favour of the animal.

On other farms close to the farm in question no parallel lessening of the extent or intensity of fluke disease was observed during the time of these experiments, nor did the number of snails there diminish—on those farms neither ducks nor geese were kept.

On one farm where before the war fluke disease was regarded as static, anti-helminthological measures produced no appreciable lessening of the flukes. Large numbers of snails were always present.

Very careful examinations conducted in 1949 over the whole area of the farm on which the experiments were carried out revealed neither snails nor empty shells—this was attributed to the activities of the birds. Examination of animals under two years old revealed no flukes at all, while those over two years old showed an incidence of 32 per cent. At the same time cattle on the other farms in the same valley and born between 1948 and 1949 were all infected.

Further work on these same lines and involving far greater areas, and the employment of flocks of ducks 20,000 strong, is in progress, but so far full details are not to hand.

Of importance also is the fact that domestic ducks will also exterminate land snails which are the intermediate hosts of *Dicrocoelium lanceolatum*; cases are recorded where these snails have been found at a density of 10-11 per square metre, but have been entirely absent after ducks have been kept in the same place.

Under experimental conditions it was found that to begin with the birds ate the snails with some reluctance, but that they later devoured them with relish; the snails appear to provide them with food and minerals, while the shells supply the grit necessary for digestion. When birds are kept without grit they will eat snail shells with avidity.

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